



XMM-Newton and Chandra

a short, and incomplete view...

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Common point : ambitious missions & launch year

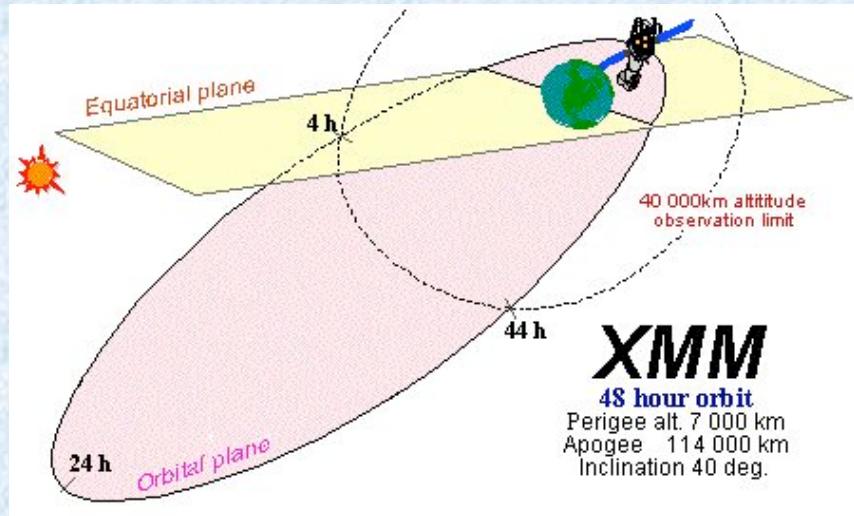


July 23rd, 1999 Chandra
NASA large observatory



Dec. 10th, 1999 XMM-Newton
ESA Cornerstone

Common point : high elliptical orbits

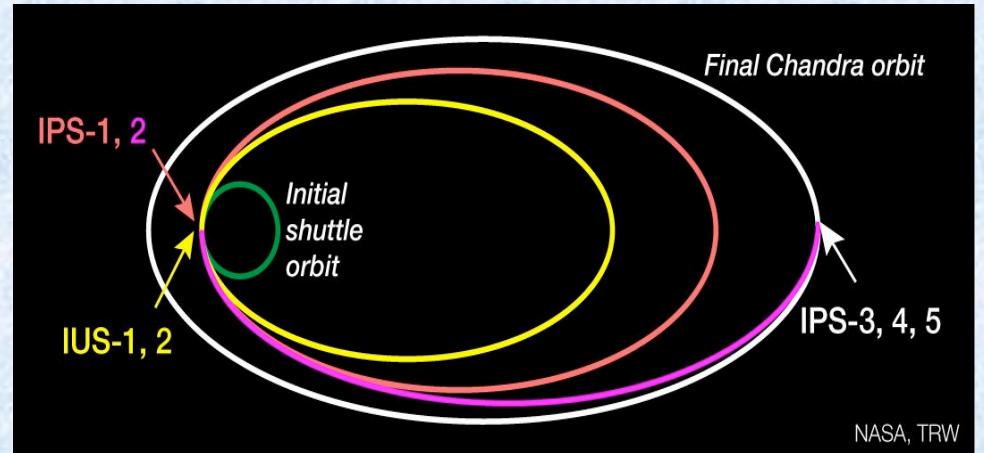


48 hours period

Perigee 20,000 km

Apogee 114,000 km

Up to 40 hours long observations



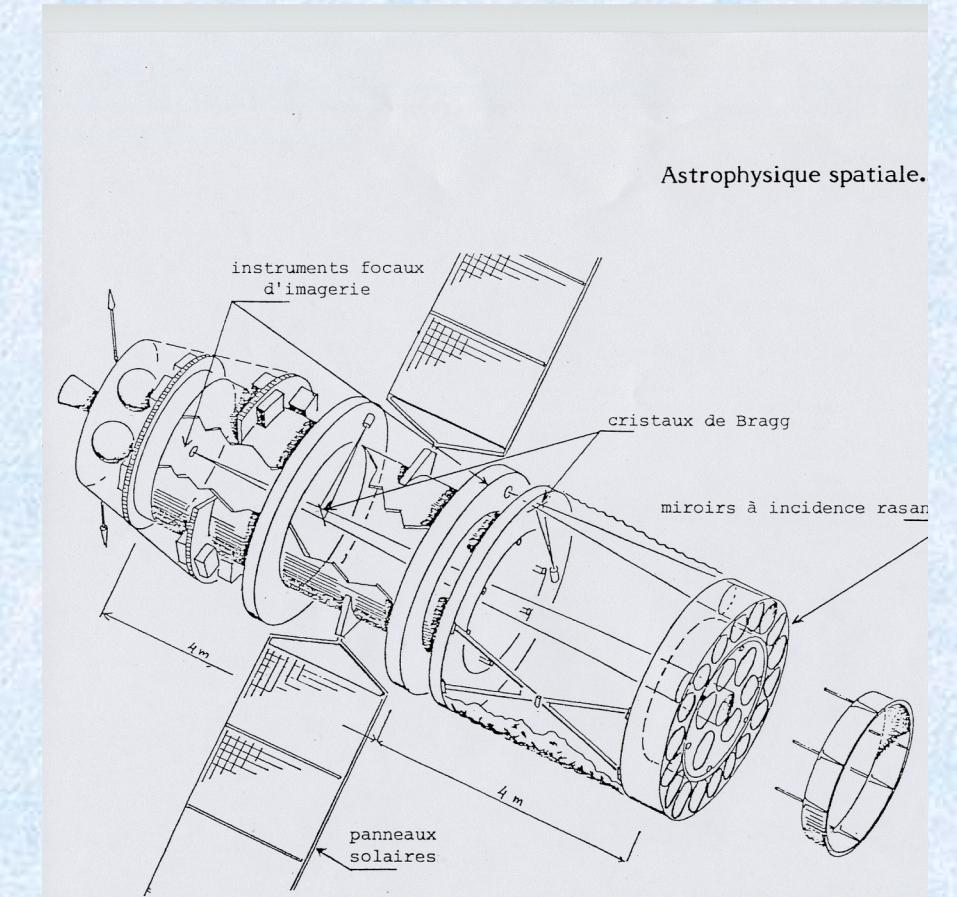
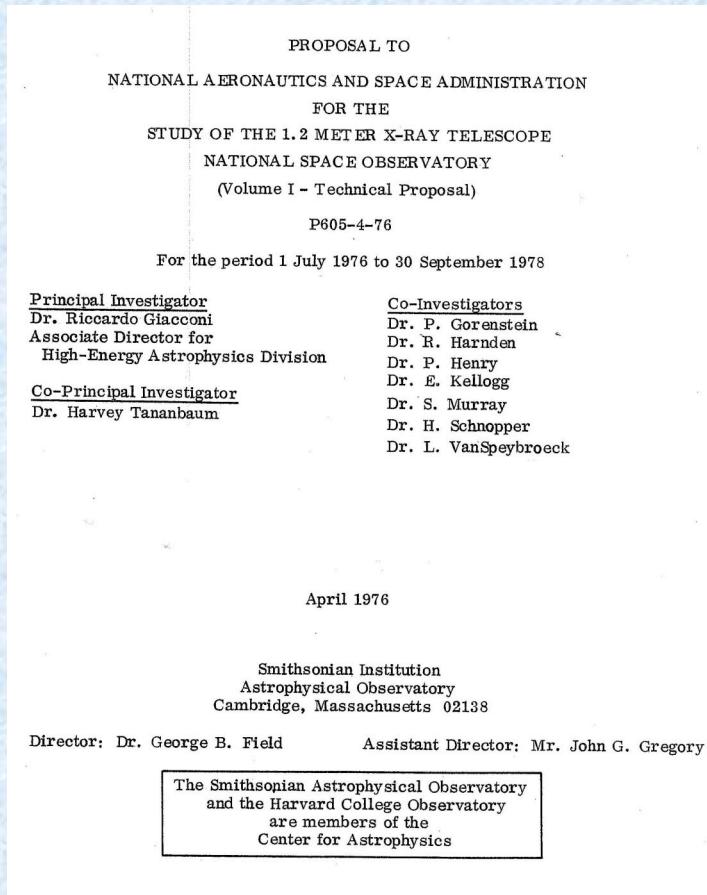
64 hours period

Perigee 28,000 km

Apogee 120,000 km

Up to 48 hours long observations

Common point : an early (formal) beginning

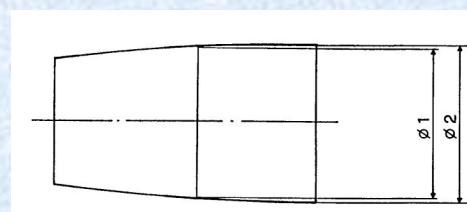
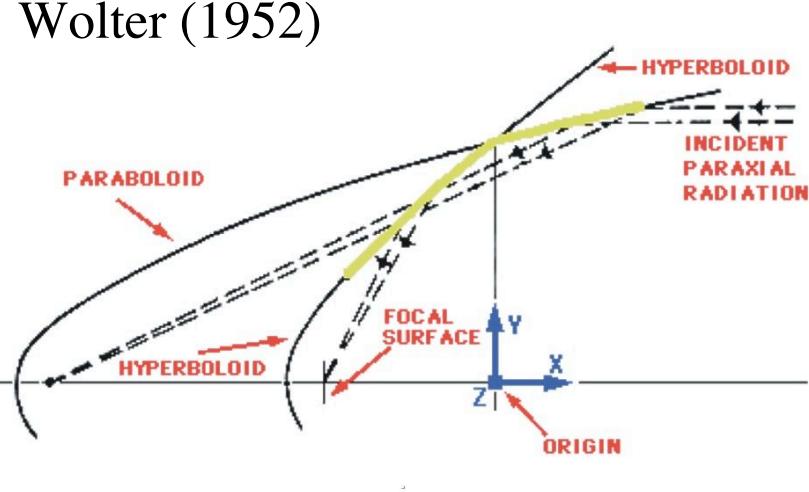
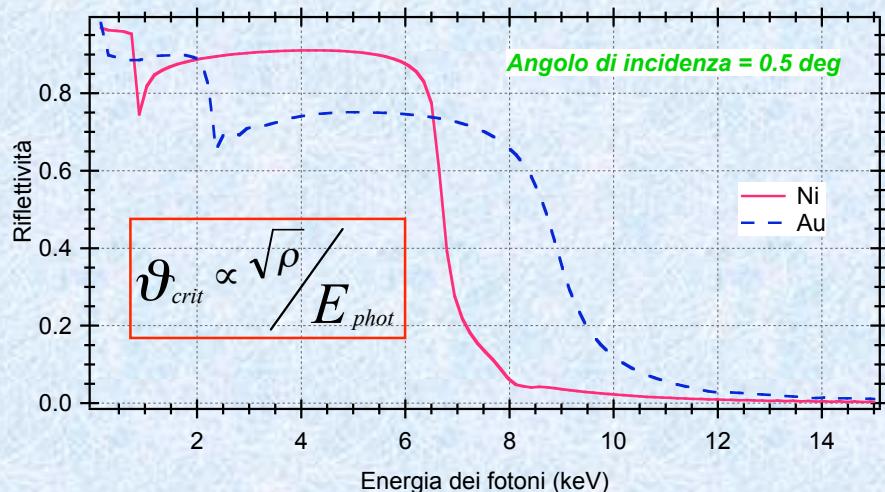


Chandra, formal beginning 1976

XMM, formal beginning 1982

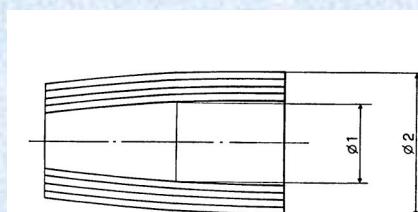
The common basis : Wolter-I X-ray optics

Grazing incidence reflection geometry:



$$S_1 = \frac{\pi (\phi_2 - \phi_1)^2}{4}$$

Small surface for single shell...

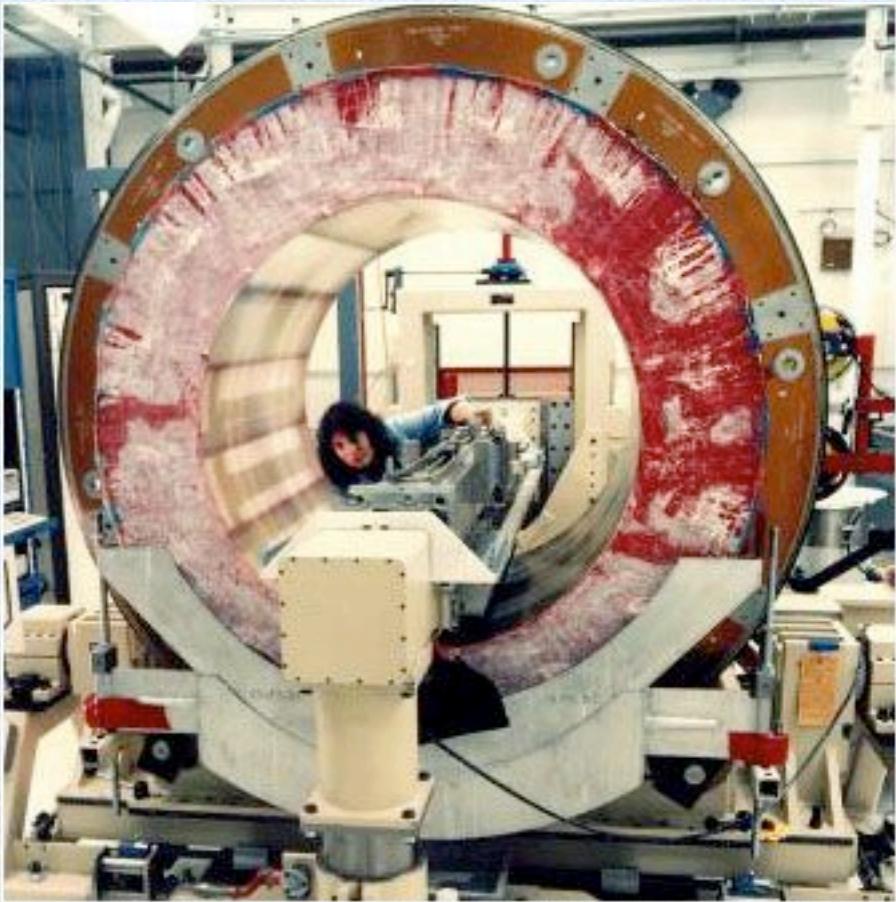


$$S_x = \frac{\pi (\phi_2 - \phi_1)^2}{4}$$

Nest shells to get collecting power !

(from G. Pareschi)

Chandra optics : high angular resolution



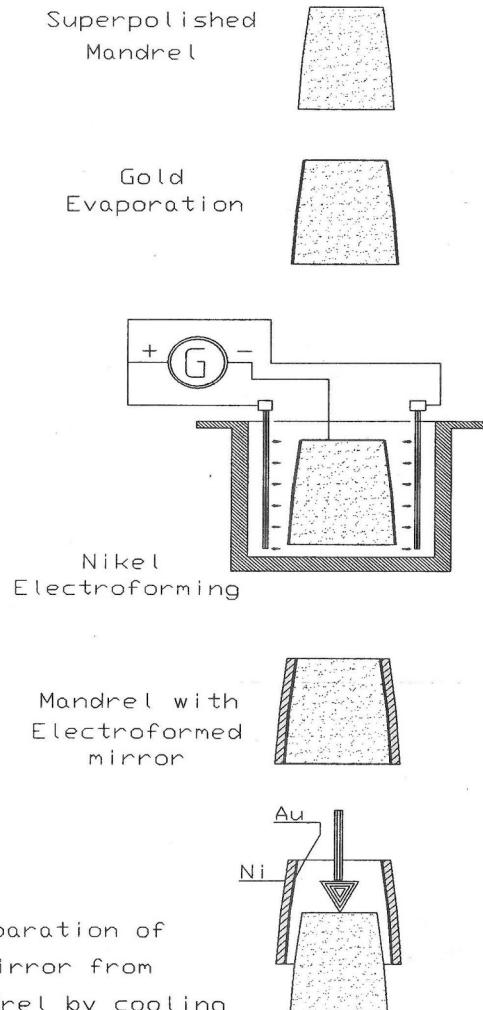
Polishing a CXO Mirror Shell



CXO Mirror Fabrication

1 mirror, 4 shells (largest 1.2 m)
Exquisite 0.25" resolution !

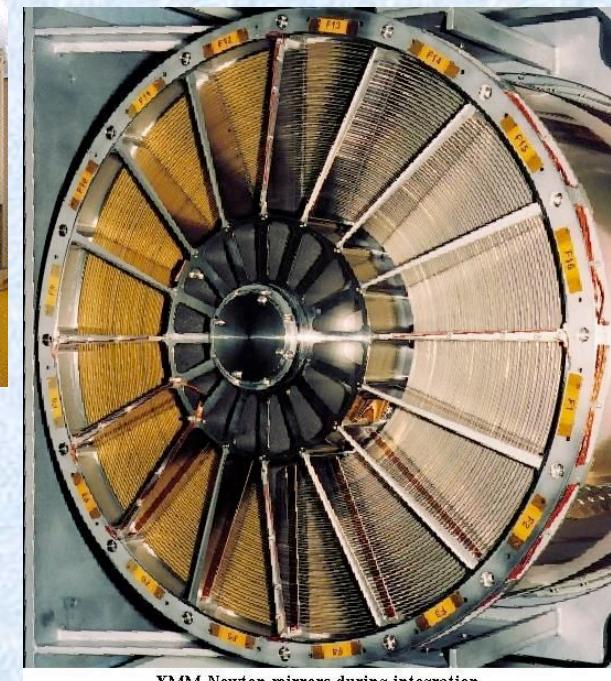
XMM-Newton optics : high throughput

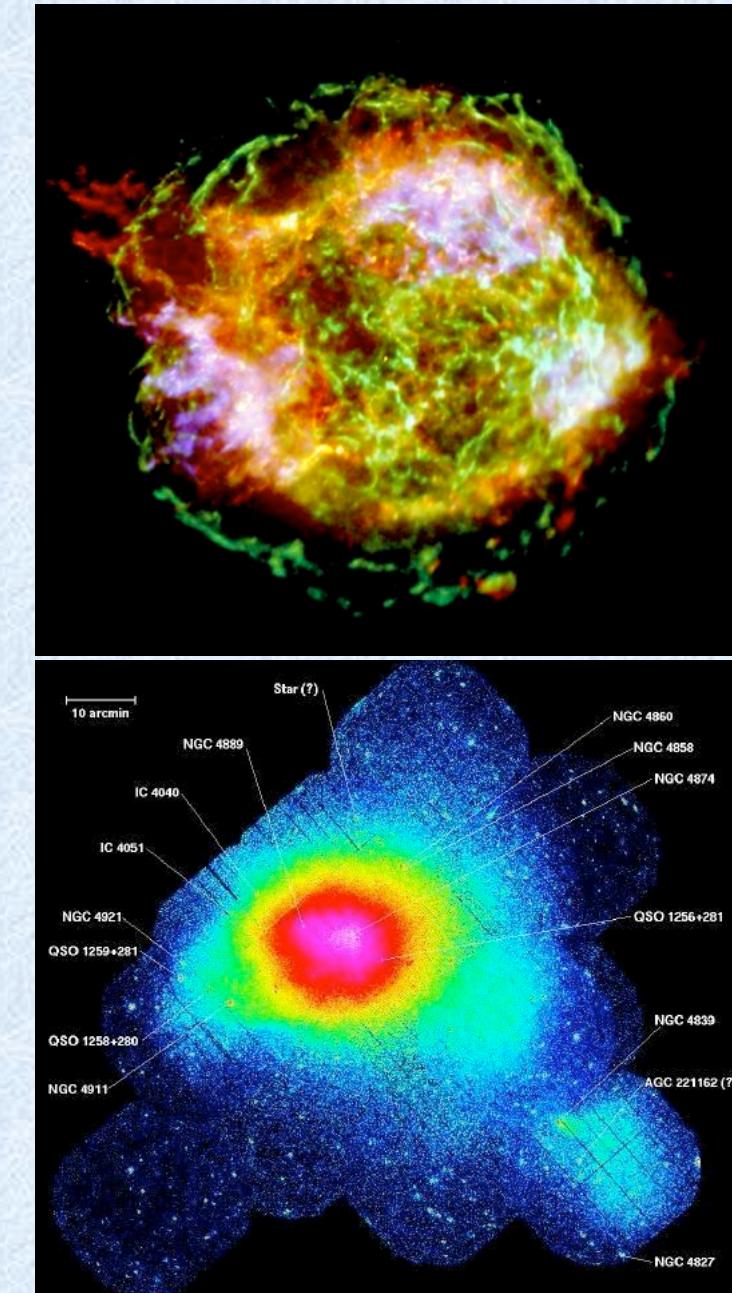


(from G. Pareschi)



3 mirrors
58 shells /mirror
15" HEW





XMM & Chandra

Angular resolution
Chandra far ahead !



CHANDRA

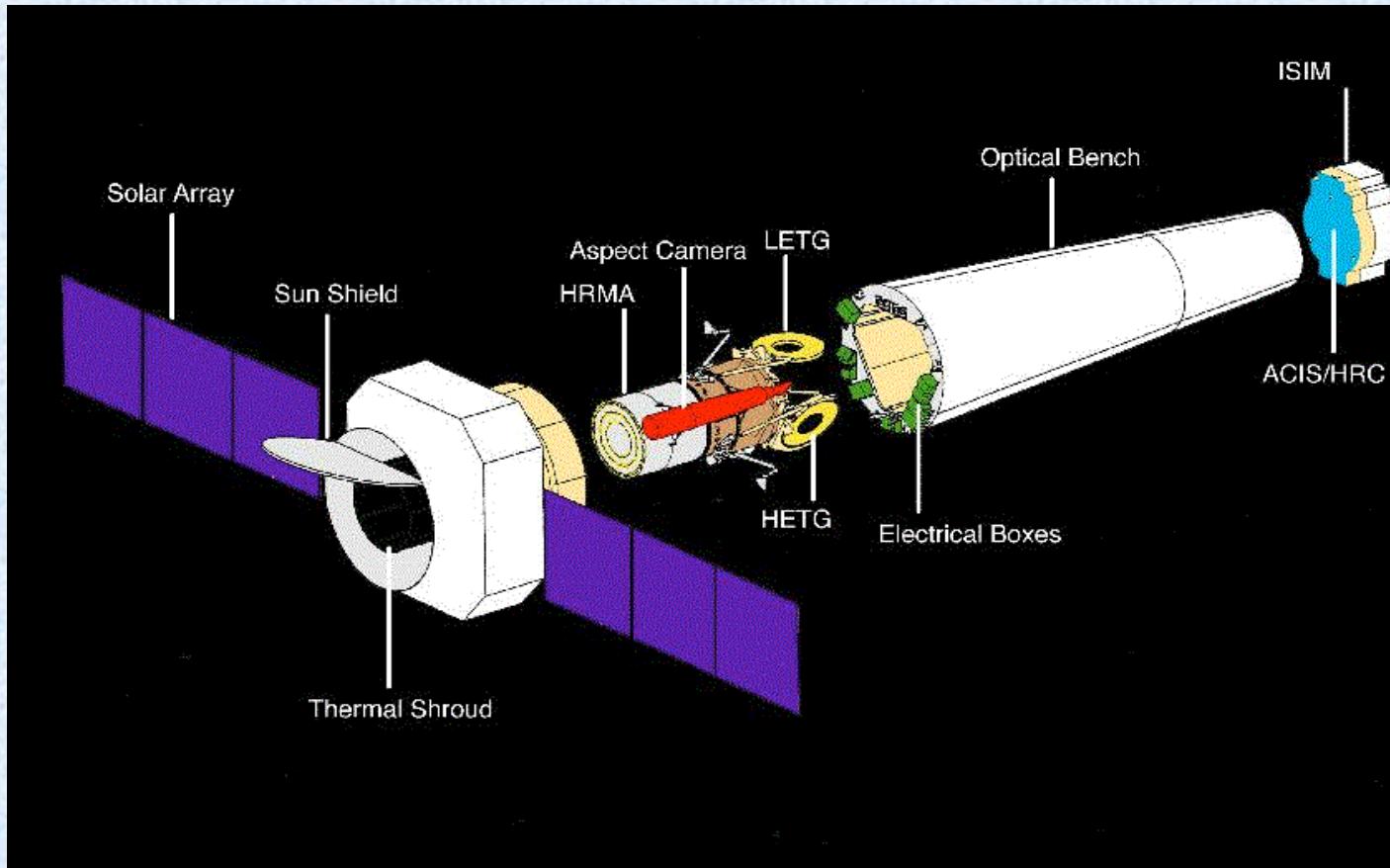
0.5"
18500 kg/m²

XMM-NEWTON

14"
2300 kg/m²

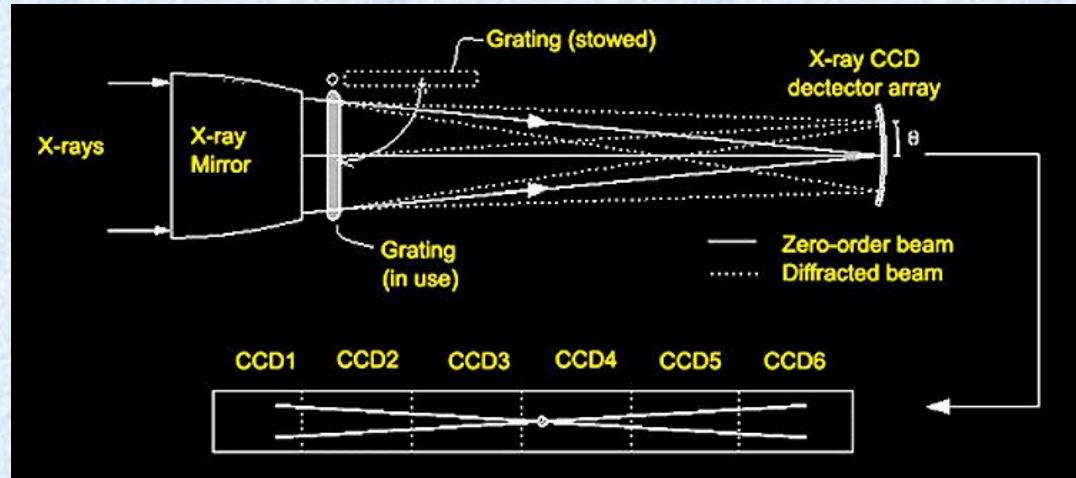
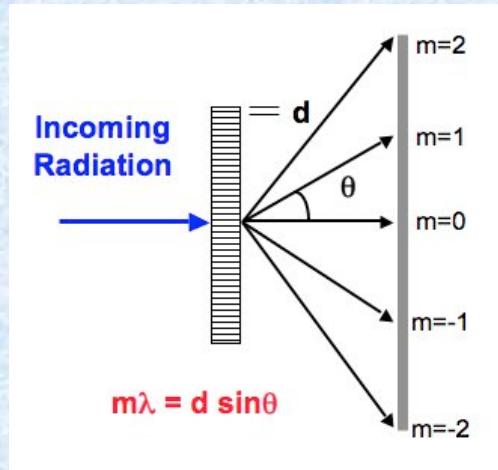
Eff.area @ 1 keV : 800 vs 4650 cm²

Chandra



High resolution spectroscopy : Chandra

Dispersive spectroscopy achieved via movable transmission gratings

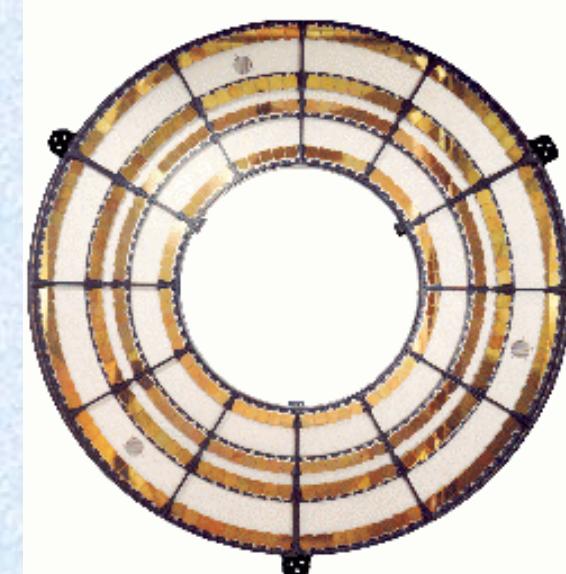


High Energy Transmission Grating Spectrometer (HETG)

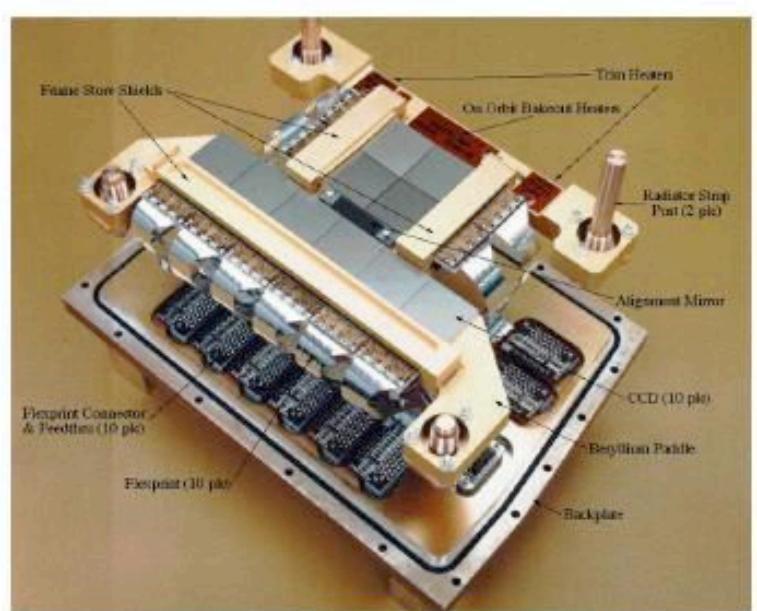
transmission grating pairs for medium and high energy (0.6-10 keV)

Low Energy Transmission Grating Spectrometer (LETG)

transmission grating for low energy (0.1-6 keV)



Chandra X-ray detecting instruments



ACIS Detector

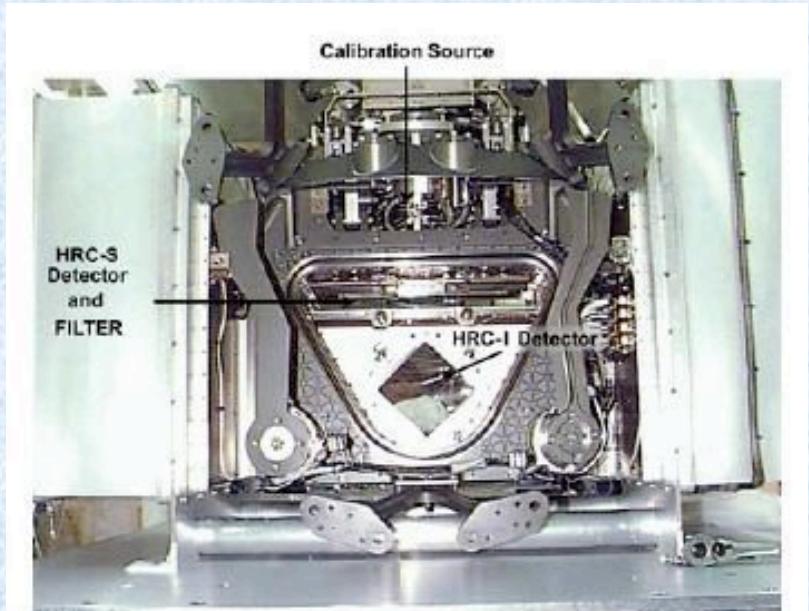
Advanced CCD Imaging Spectrometer (ACIS)

Range : 0.1–10 keV

CCDs : 1024x1024 pixels, 16 μm each (0.5")

ACIS-I : 4 CCDs cover 16'x16'

ACIS-S : 6 CCDs, grating readout array



HRC Detector

High Resolution Camera (HRC)

Range : 0.1–10 keV

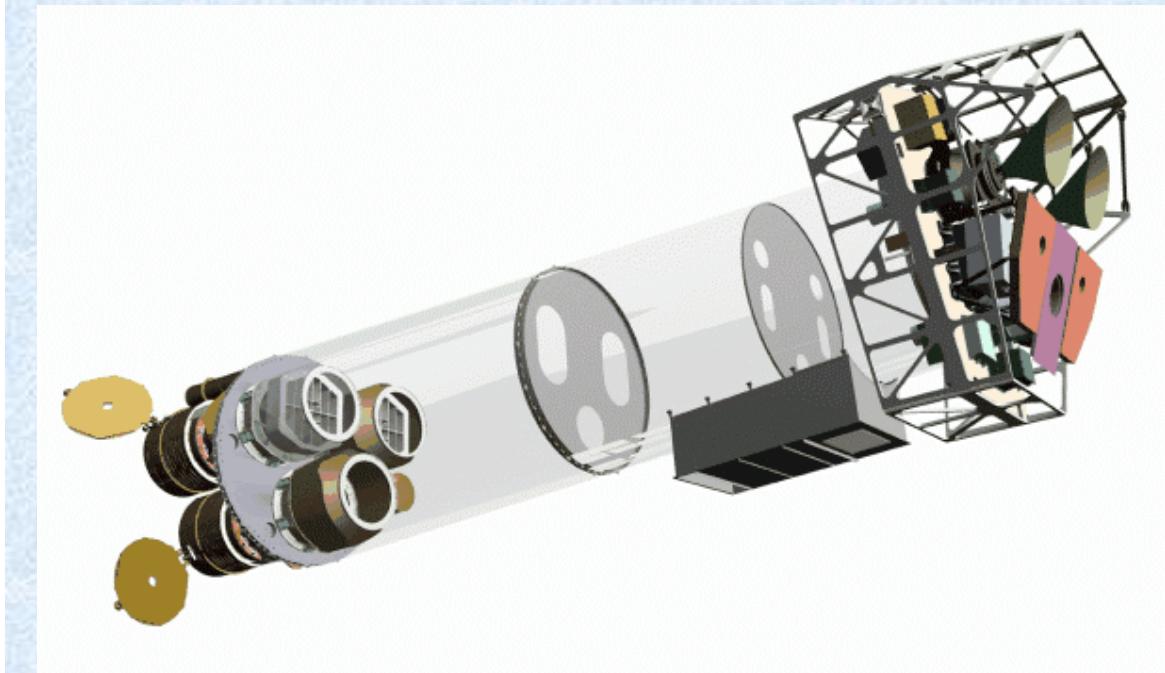
microchannel plate (FWHM 20 μm)

High time resolution (16 μs)

HRC-I : 31'x31' field of view

HRC-S : low energy grating readout

XMM-Newton



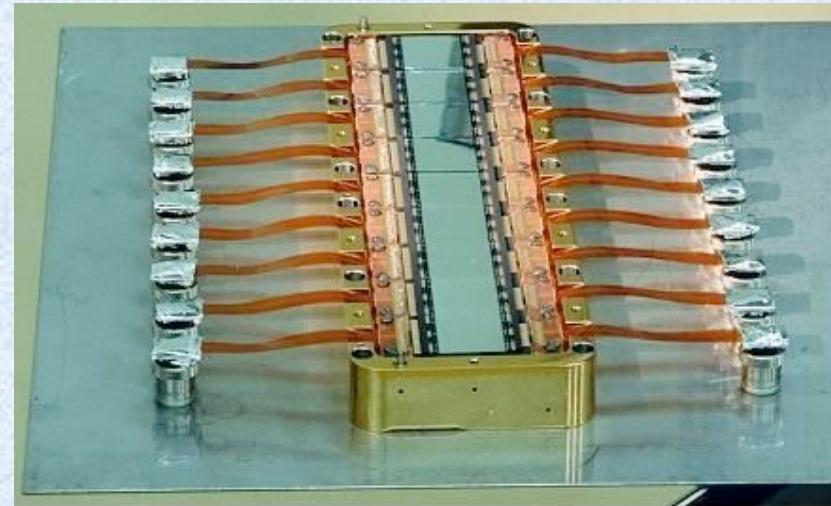
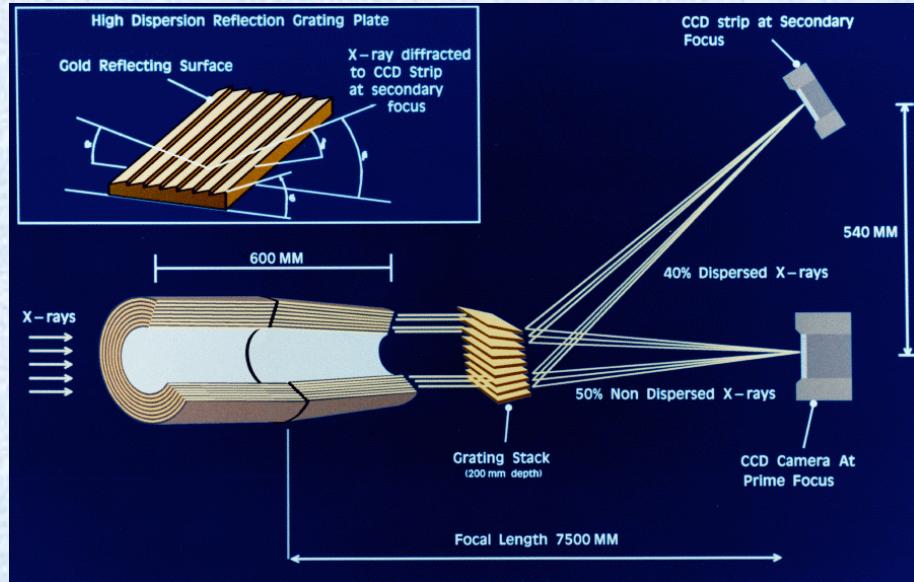
The 3 X-ray mirrors feed beams of X-rays to two instrument sets:

- The EPIC Cameras (3)
- The Reflection Grating Spectrometers (2)

A co-aligned visible light-UV telescope : The Optical Monitor (30 cm diameter, 17' arcmin FOV, 7 filters, 2 grisms)

All instruments can operate at the same time

High resolution spectroscopy : XMM-Newton



XMM-Newton Focal Plane Camera (RFC)

Image courtesy of EKV Ltd., SRON, Paul Scherrer Institute

European Space Agency



Image courtesy of Columbia University

European Space Agency

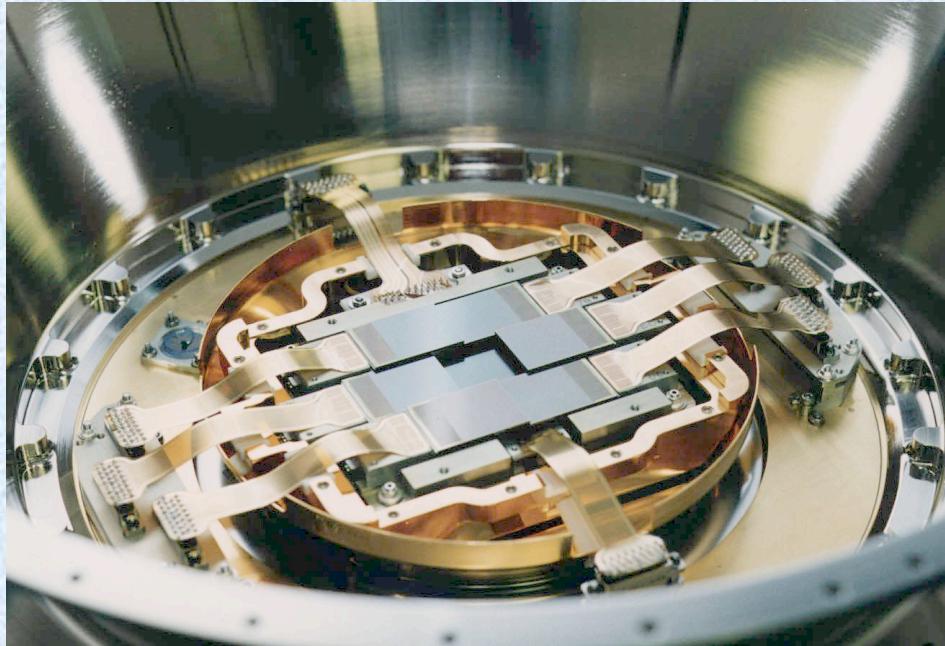
2 RGS spectrometers

Dispersive spectroscopy by permanently mounted reflection gratings

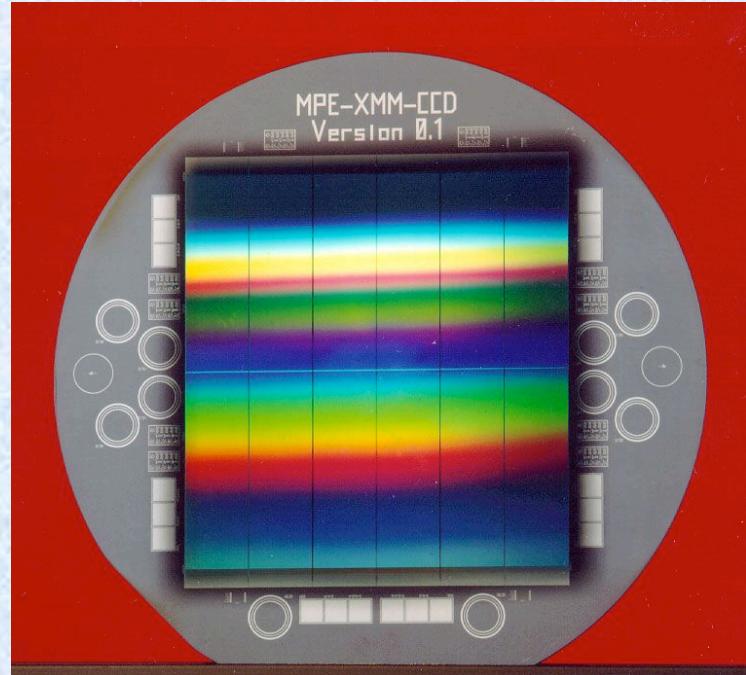
9 CCD detectors

Range : 0.35 keV - 2.5 keV

The European Photon Imaging Cameras

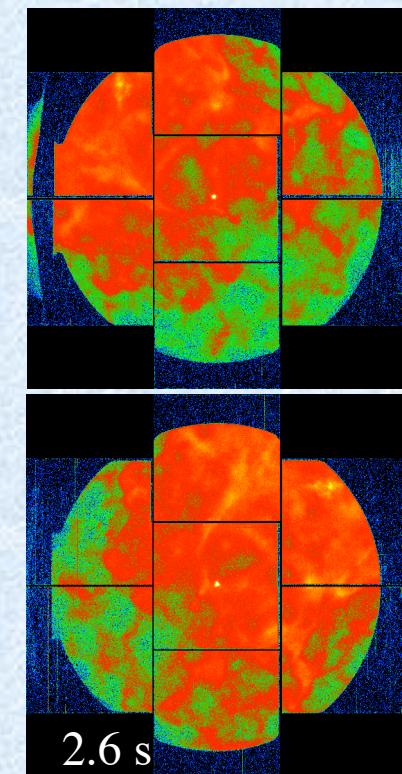
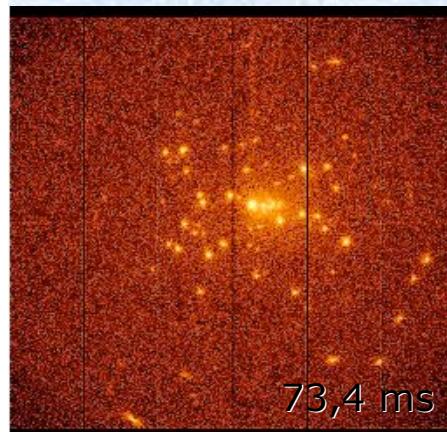


2 MOS cameras, 7 CCDs each
Cover a 30' diametre FOV
1 CCD : 600x600 pixels of 40 μm (1")
Range : 0.15 keV - 12 keV



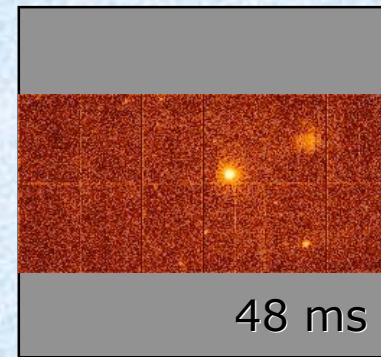
1 PN camera, 12 CCDs on monolithic Si
Cover a 30' diametre FOV
1 CCD : 64x200 pixels of 150 μm (4")
Range : 0.15 keV - 15 keV

Full frame

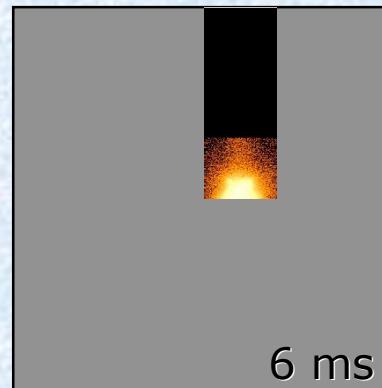


The EPIC modes

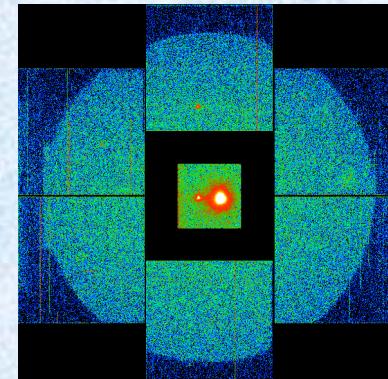
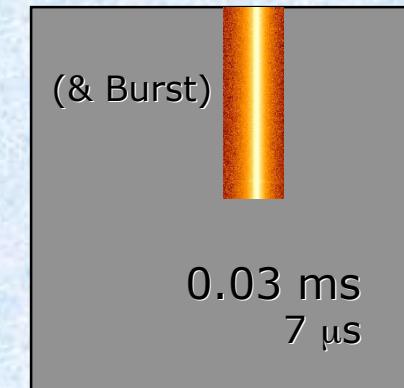
Large Window



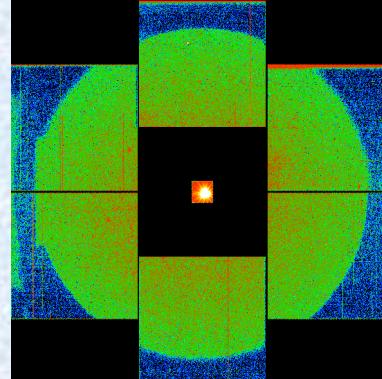
Small Window



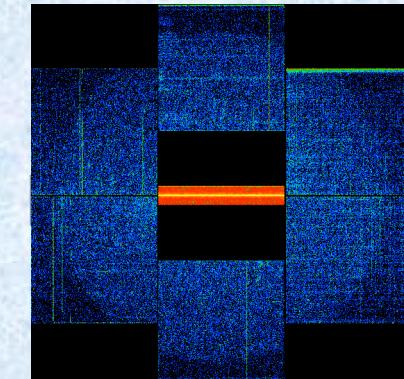
Timing
(& Burst)



2.7 s outer CCDs

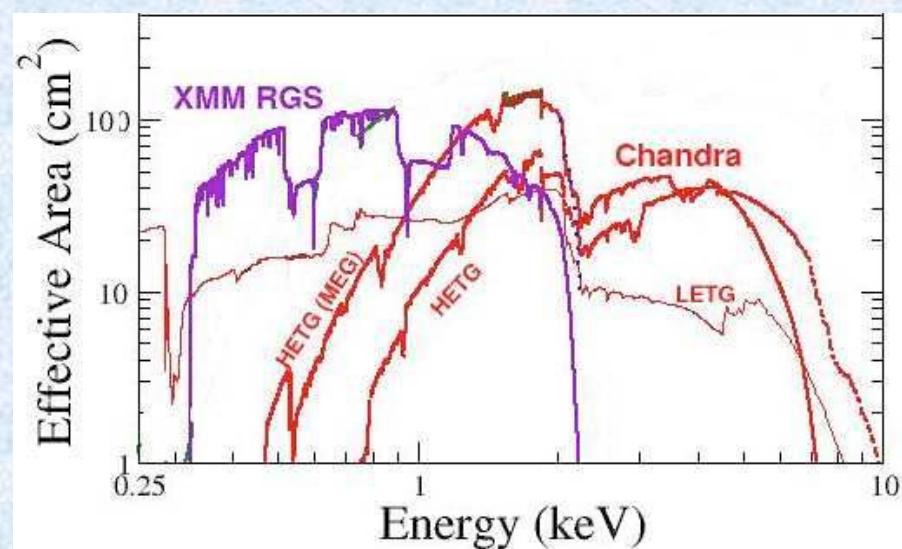
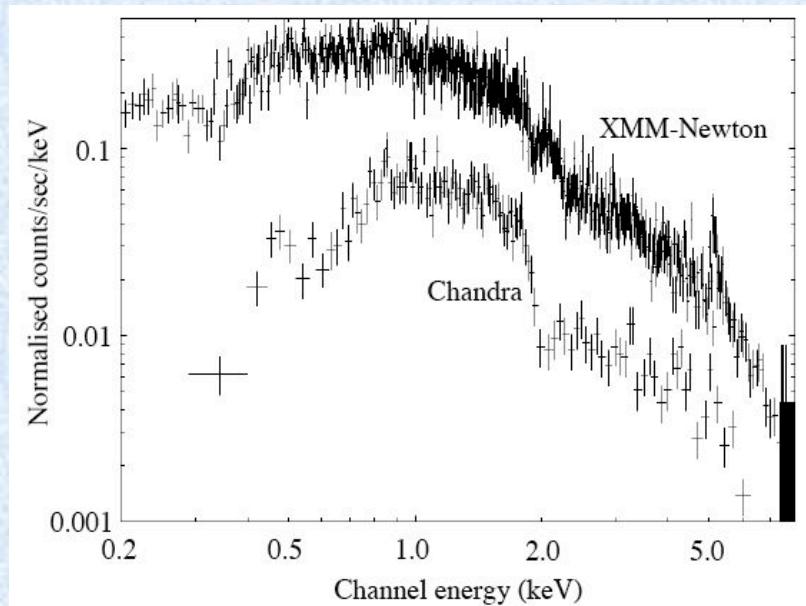
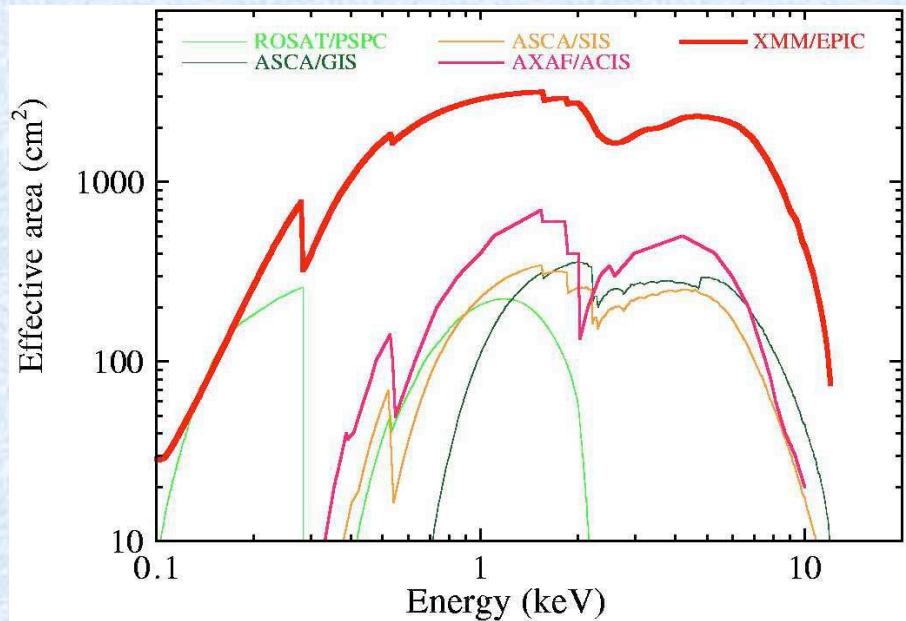


2.7 s outer CCDs



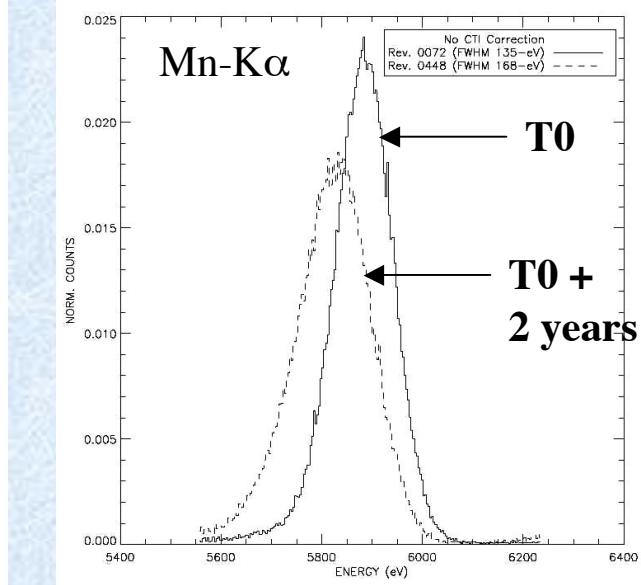
2.6 s outer CCDs

Compared collecting powers

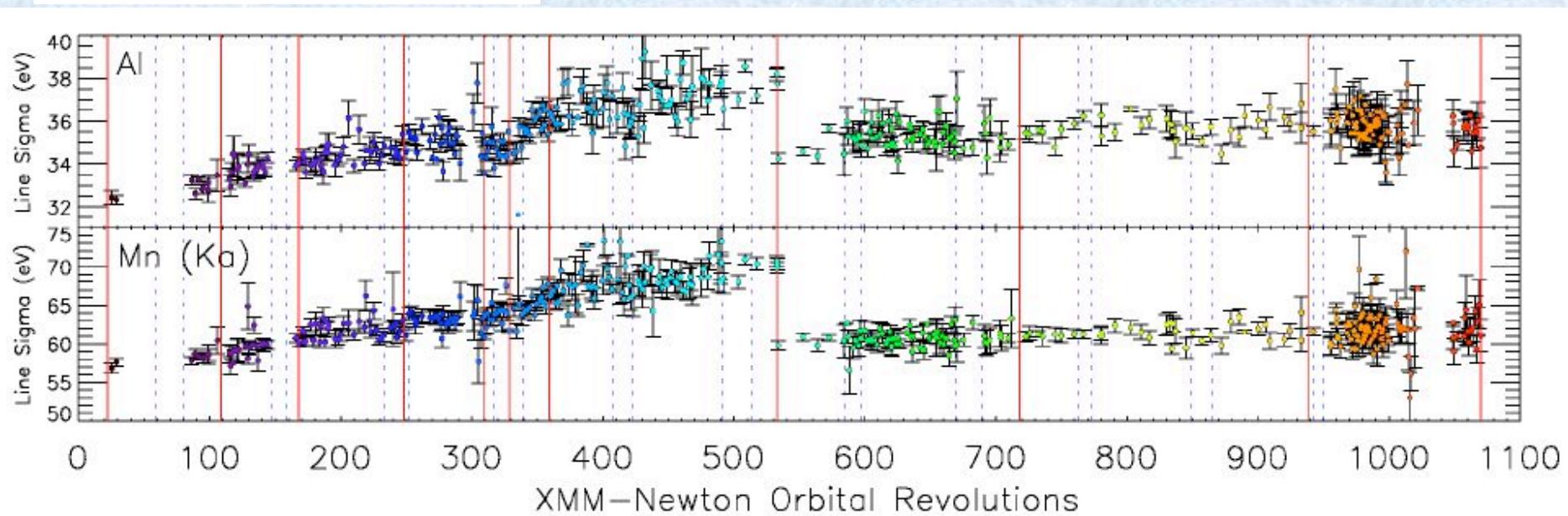


$\Delta E @ 1 \text{ keV}$
 1.0 eV HETG
 2.9 eV RGS
 5.4 eV LETG

Effect of radiations on CCDs (EPIC-MOS)



Charge transfer inefficiency during clocking
of charges in CCDs

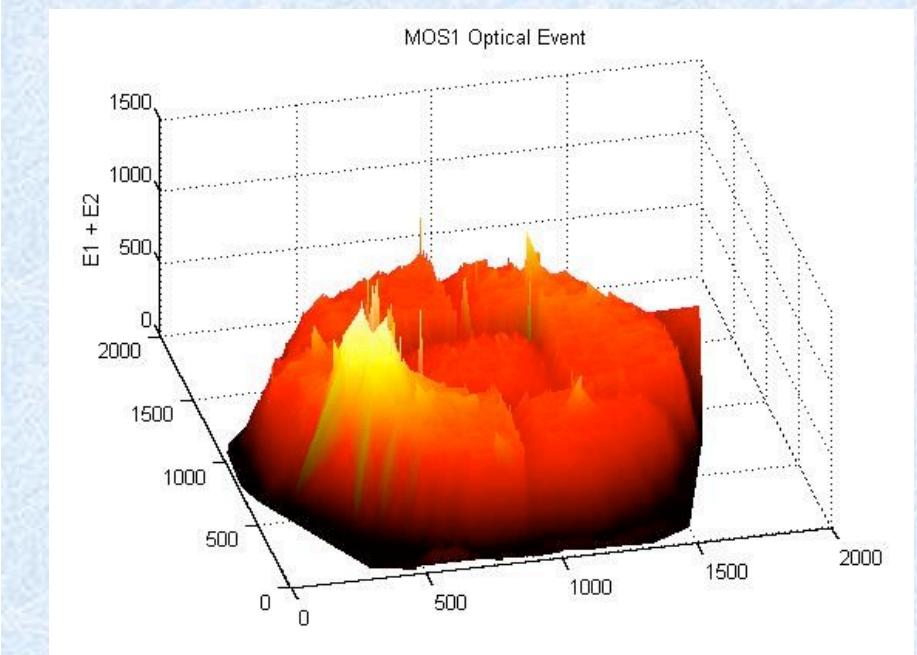


Dramatic effect of alien impacts

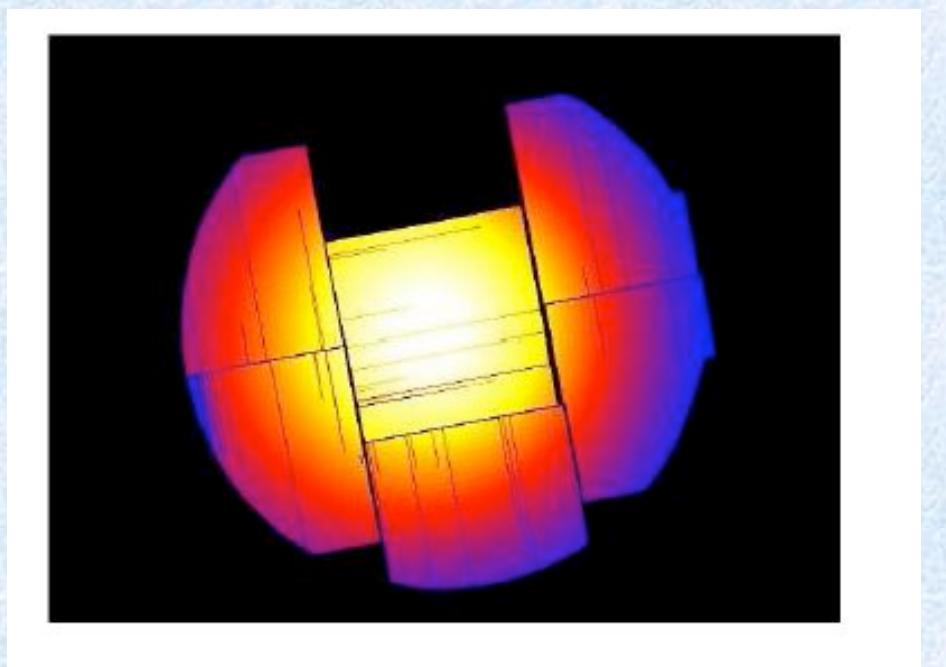
EPIC has suffered 4 micrometeorites hits :

1 for MOS 2 (rev. 107), 1 for PN (rev. 158)

2 for MOS 1 (rev. 325 & rev 961)



Impact MOS 1 rev 325



Loss of CCD6 MOS 1 rev 961



Future (of these missions)



- *High rate of findings, publications, and high pressure for each AO*
- *Reasonable slow long term degradation*
- *No consumable problems...*
- *Can continue well over 2010 if funding follows !*



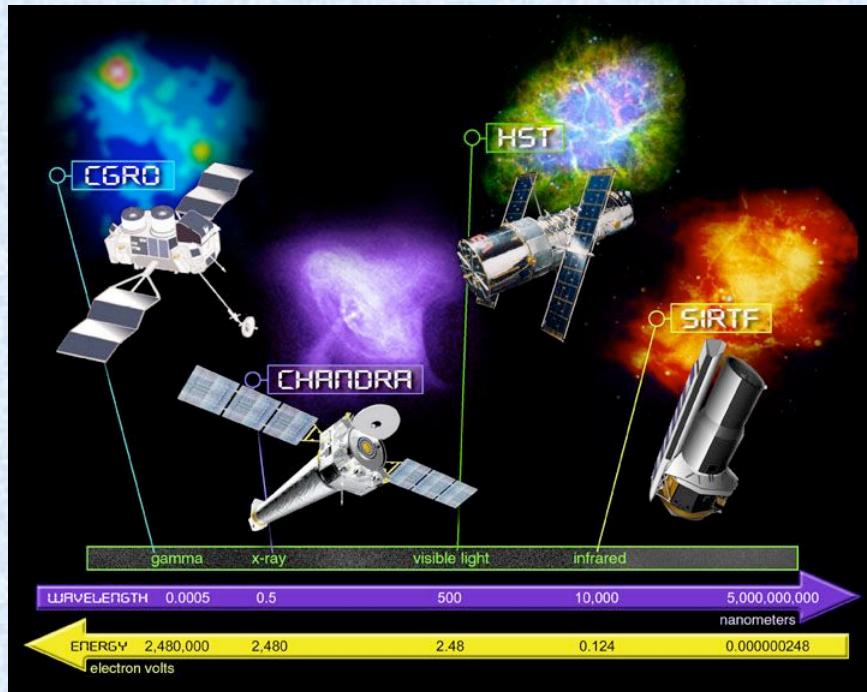
XMM & Chandra



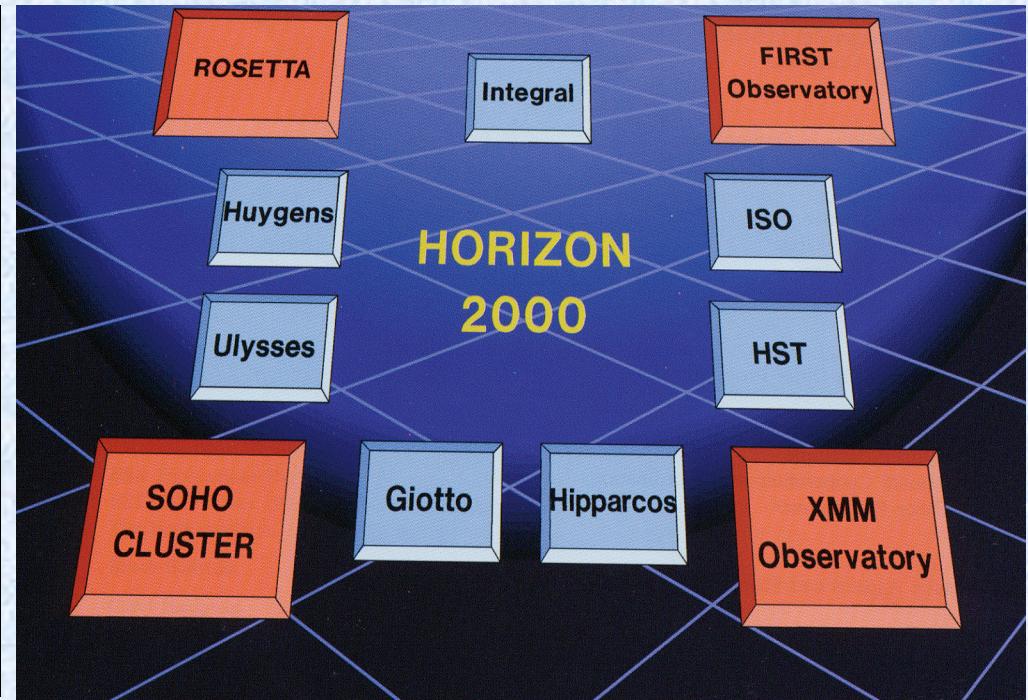
Cargese

April 13 2006

Common point : ambitious missions



NASA large observatory



ESA cornerstone